MATLAB TUTORIAL 1

Figure: Old Faithful erupting

MATLAB TUTORIAL 1

Summary statistics for waiting time

mean 72.4 mins

median 76 mins

mode 78 mins

standard deviation 13.7 mins

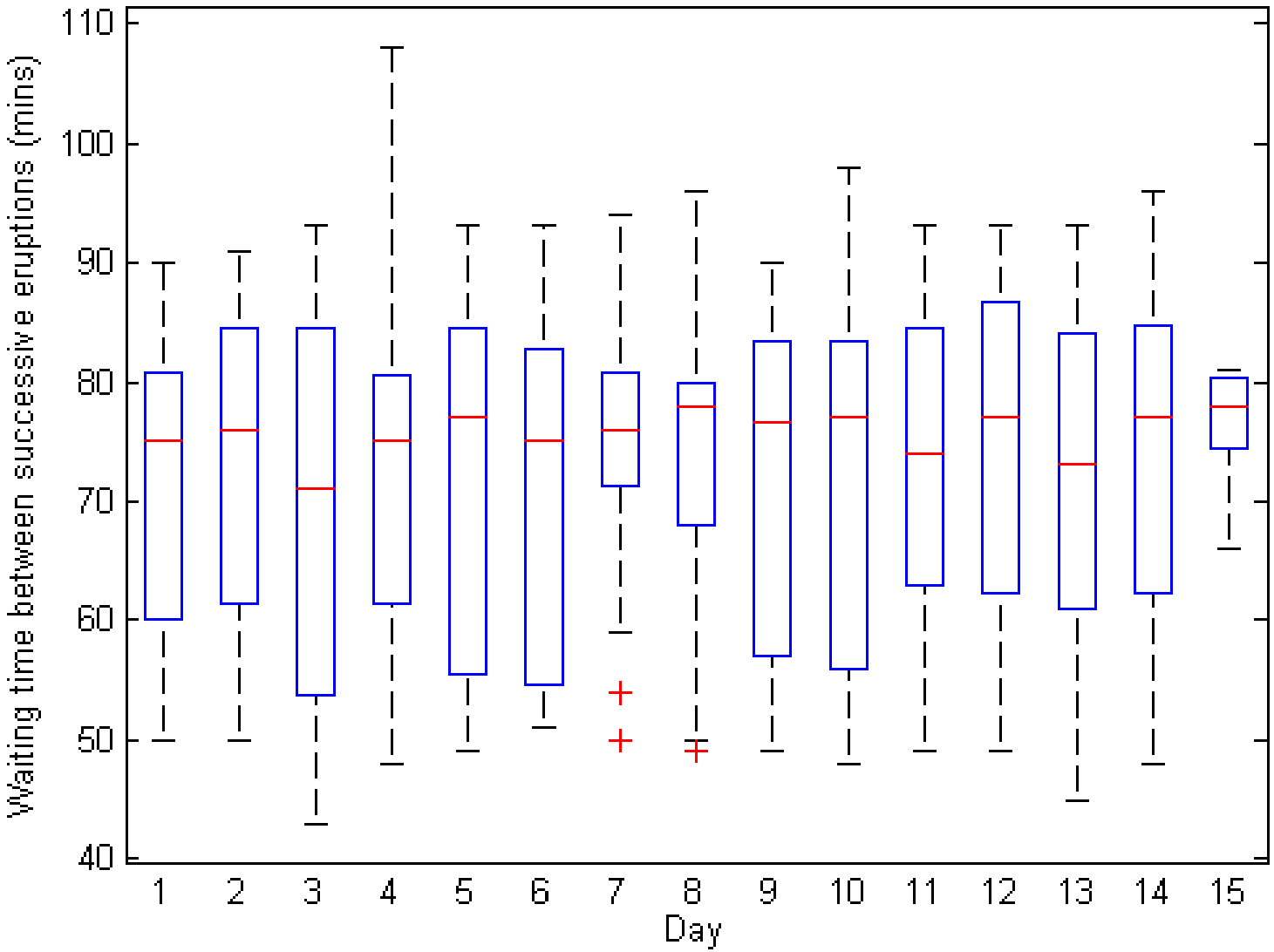
Q1 60.0 mins

Q3 82.3 mins

MATLAB TUTORIAL 1: BOX PLOTS

```
 % boxplot by day
figure()
boxplot(waiting, day)
xlabel('Day')
ylabel('Waiting time between successive eruptions
(mins)')
```

MATLAB TUTORIAL 1



MATLAB TUTORIAL 1: BOX PLOTS

8. How are the ends of the whiskers determined? Can you change this?
   `'whisker' Maximum whisker length W. Default is W=1.5.`
9. What patterns in waiting time, if any, do you notice? What can you say about day-to-day variation? How long do you predict you need to wait for the next eruption?

MATLAB TUTORIAL 1: HISTOGRAMS

```
 figure()
nbins = [ 10 20 50 ]
for bi = 1 :  3
bins = linspace(min(waiting), max(waiting),
nbins(bi));
freq = hist(waiting, bins);
class = bins(2) - bins(1);
relfreq = freq/(sum(freq)*class);
ksestimate = ksdensity(waiting, bins);
subplot(1, 3, bi);
hold on;
bar(bins, relfreq, 1, 'FaceColor', 'w');
plot(bins, ksestimate, 'b-');
end
hold off
```

MATLAB TUTORIAL 1: HISTOGRAMS

Or use the `histogram` command with option `'Normalization' 'pdf'`.

This calculates and plots the relative frequency histogram and avoids using `hist`, `bar`, and calculating the relative frequency by hand.

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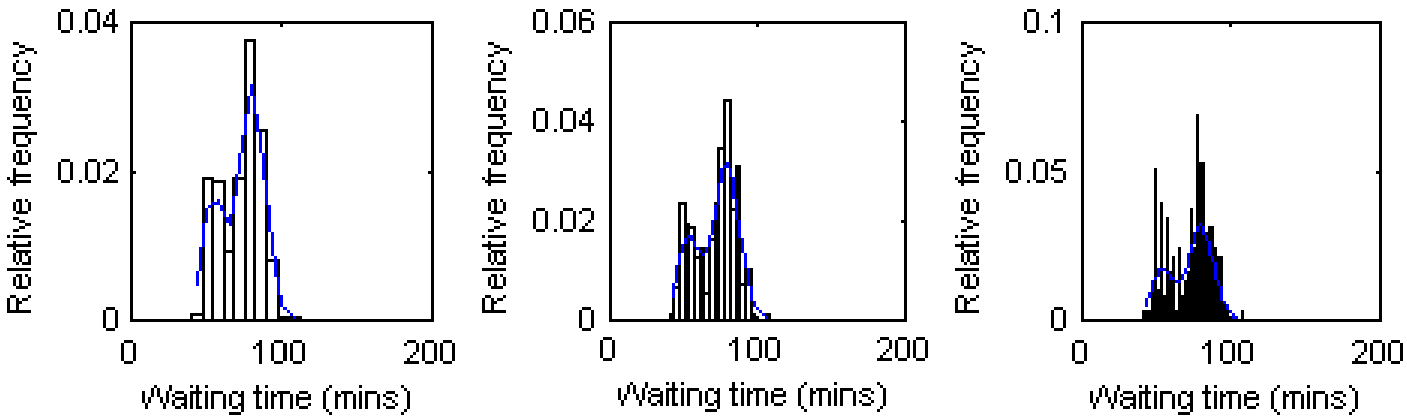


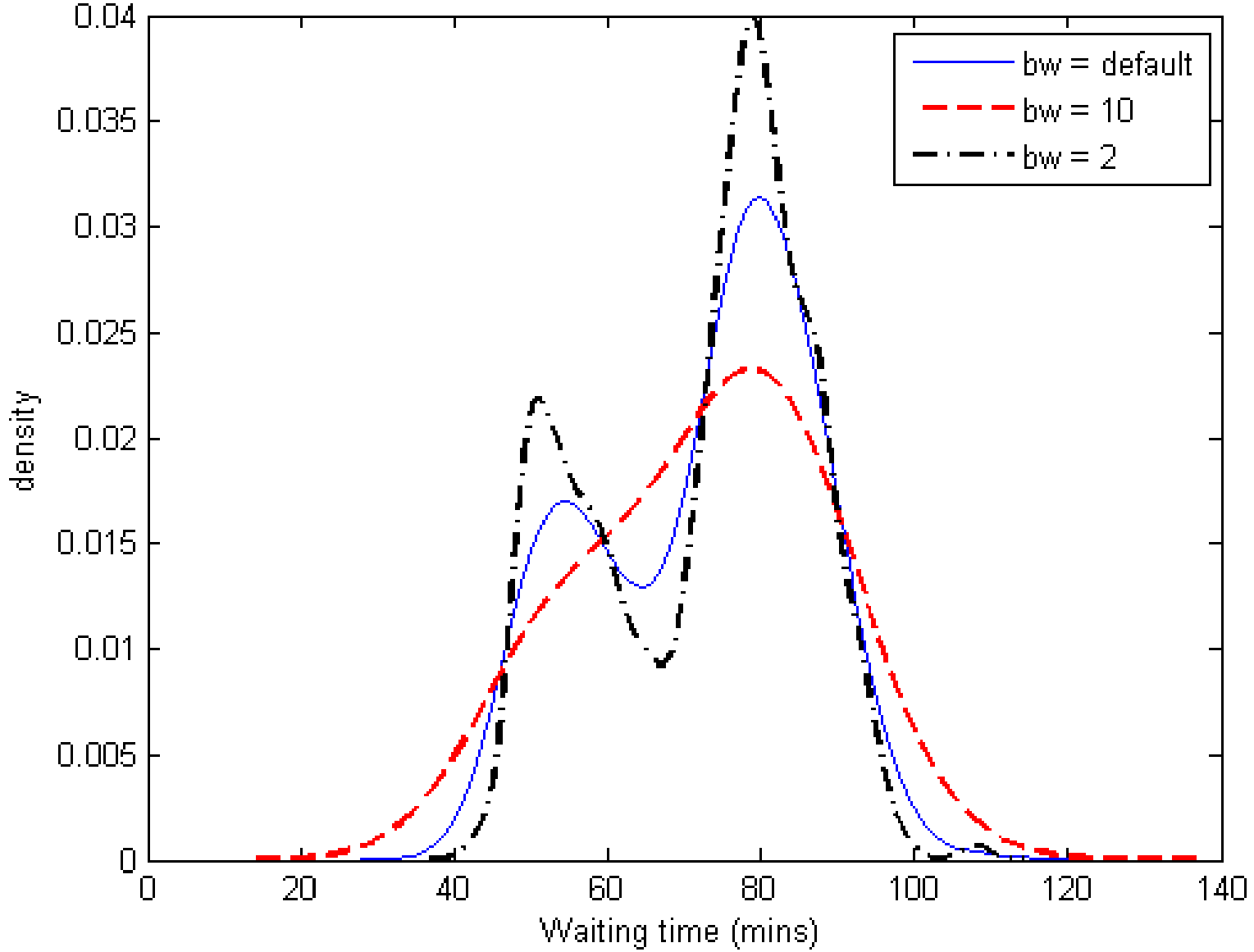
MATLAB TUTORIAL 1: HISTOGRAMS

9. How many bins would you choose to best represent the distribution of waiting times? A commonly used criterion to determine the number of bins is Sturges' formula: $1 + \log_2 n$, where n is the sample size - do you think this is a good choice for these data?
   Sturges' formula gives 9.15 as starting point for the number of classes. More appropriate for normal data (also works better for large samples).
10. Comment on the histogram and kernel density smooth versus the boxplot for the "Old Faithful" waiting times.

MATLAB TUTORIAL 1: KERNEL DENSITY

```
 [f,xi,bw] = ksdensity(waiting)
figure()
plot(xi, f)
hold on
(f,xi] = ksdensity(waiting,'width',10);
plot(xi,f,'--r','LineWidth',1.5);
(f,xi] = ksdensity(waiting,'width',2);
plot(xi,f,'-.k','LineWidth',1.5);
legend('bw = default','bw = 10','bw = 2');
hold off
```

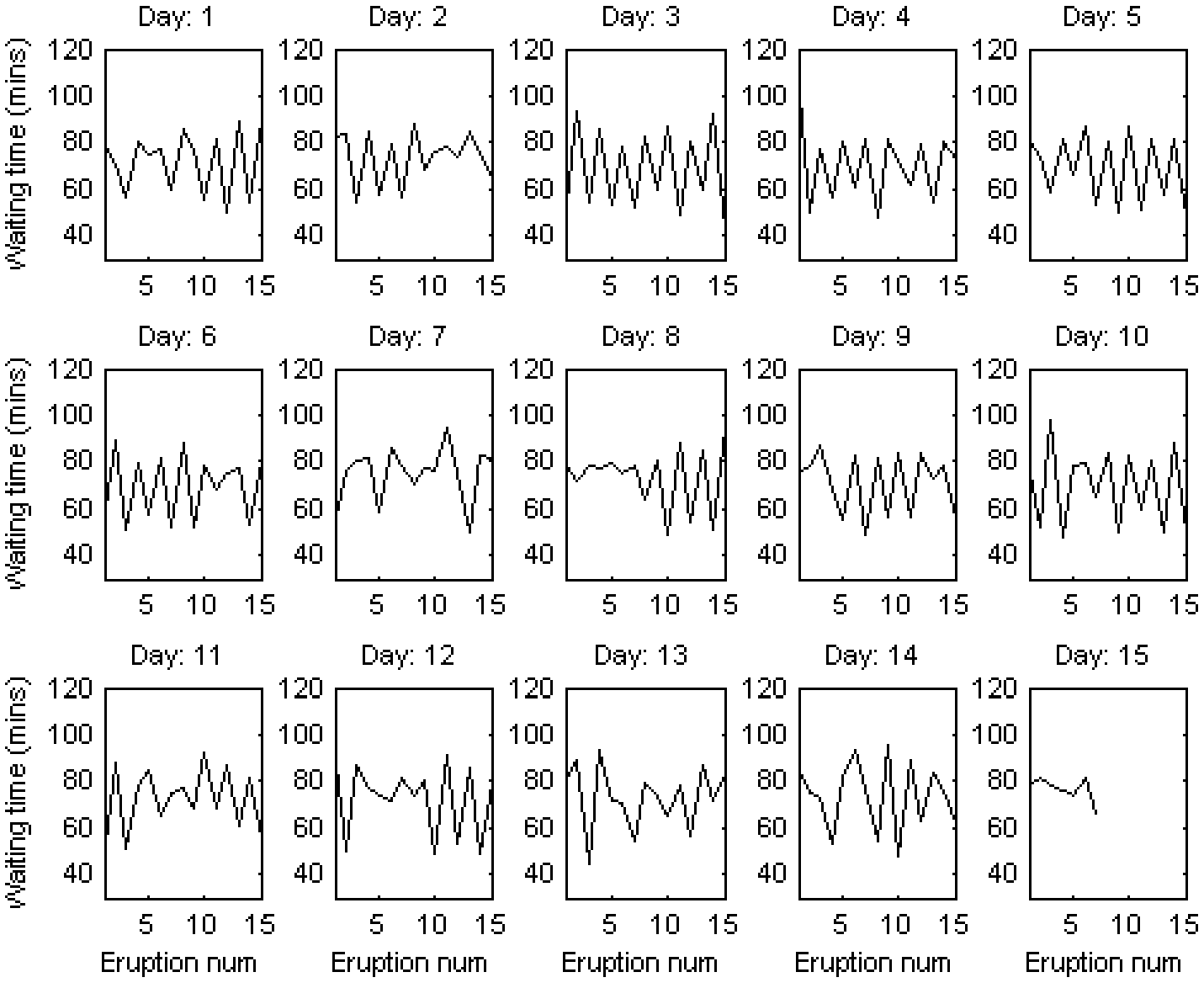
MATLAB TUTORIAL 1: KERNEL DENSITY



MATLAB TUTORIAL 1: TIME SERIES

```
for mi = 1 :  15
loc = find( day == mi );
subplot(3, 5, mi);
hold on;
plot(waiting(loc), 'k-');% line plot
set(gca, 'Box', 'On', 'FontSize', 8);
xlim([1 15]);
ylim([30 120]);
if mod(mi, 5) == 1
ylabel('Waiting time (mins)'); % label y-axes
end
if mi > 2*5
xlabel('Eruption num'); % label x-axes
end
title(['Day:  '  num2str(mi)]);
end
```

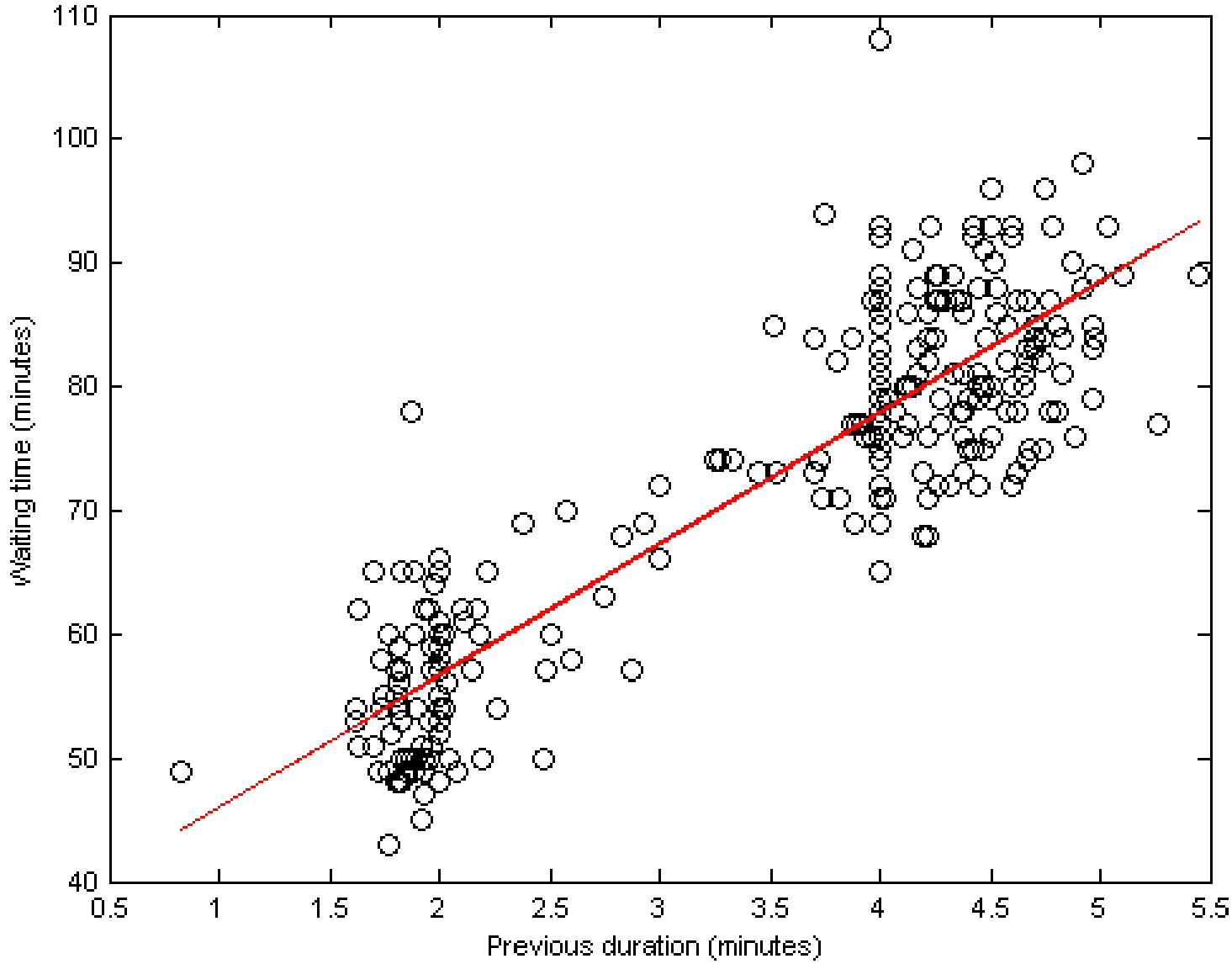
MATLAB TUTORIAL 1: TIME SERIES



MATLAB TUTORIAL 1: SCATTER PLOT

```
n = length(duration);
% do linear regression
lagduration = lagmatrix(duration, 1)
Y = waiting;
X = [ ones(n, 1) lagduration ];
B = regress(Y, X);
% fit linear regression (predicted values)
waitingest = B(1) + B(2)*lagduration;
% plot data and line of best fit
figure(4); clf;
hold on;
plot(lagduration, waiting, 'ko'); % plot data
plot(lagduration, waitingest, 'r-'); % plot line of
best fit
```

MATLAB TUTORIAL 1: SCATTER PLOT



MATLAB TUTORIAL 1: SCATTER PLOT

What does this plot suggest to you? Do you think the linear fit is appropriate? What is your predicted waiting time now? Is there other information you could use to improve your prediction?

MATLAB TUTORIAL 1: RAW DATA

waiting	duration	day
80	4.02	1
71	2.15	1
57	4	1
80	4	1
75	4	1
77	2	1
60	4.38	1
86	4.28	1
77	2.03	1
56	4.83	1
81	1.83	1
50	5.45	1
89	1.62	1
54	4.87	1
90	4.38	1
73	1.77	1
60	4.67	1
83	2	1
65	4.73	1

MATLAB TUTORIAL 1: PREDICTIONS

Looking at the raw data, some of the durations are recorded as integer values, with less precision than others - why do you think this is?

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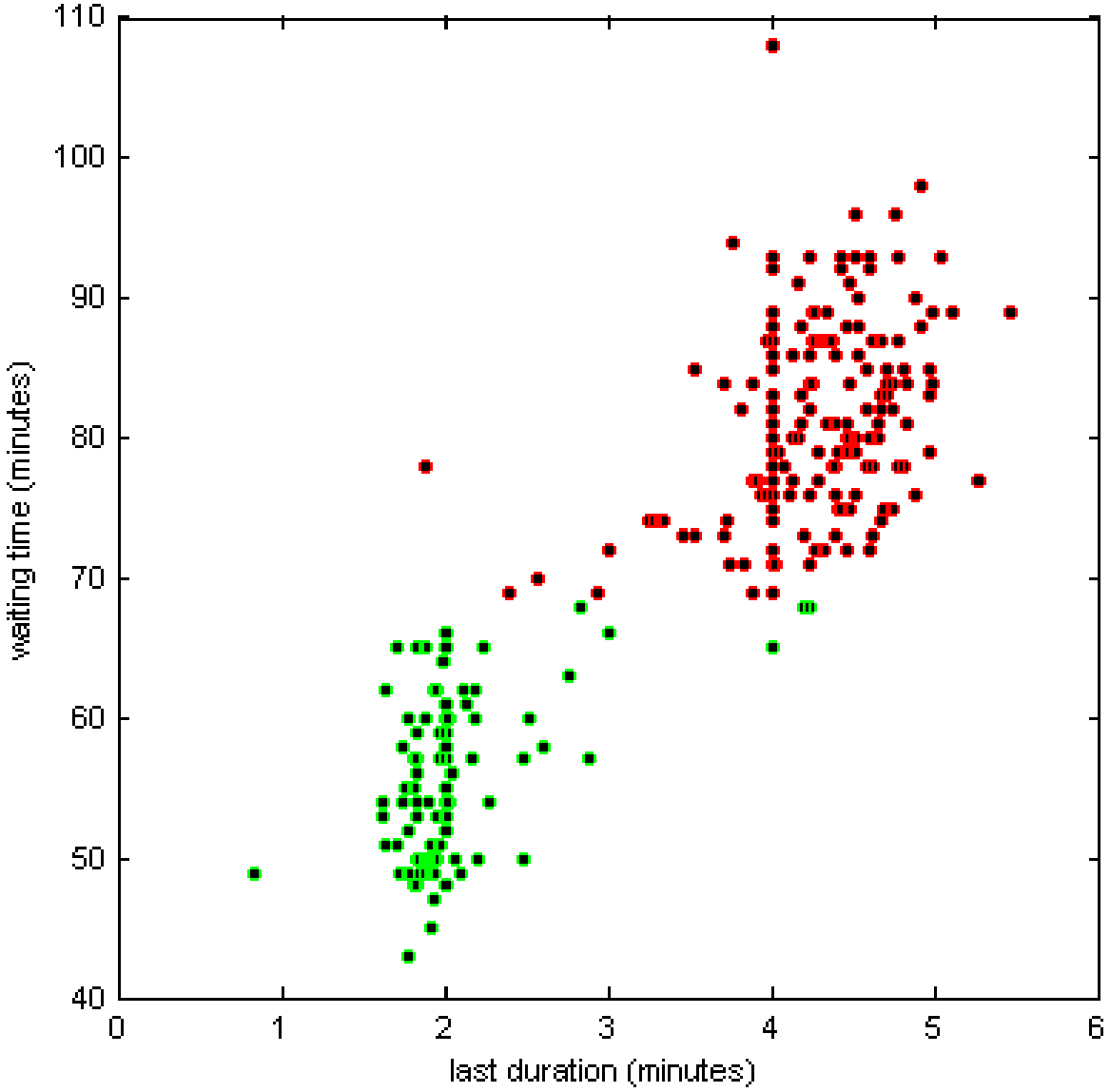
Looking at the raw data, some of the durations are recorded as integer values, with less precision than others - why do you think this is? These were night time durations. Possibly the night time data were estimated not measured? How might this affect your predictions - how might you deal with this?

MATLAB TUTORIAL 1: CLUSTER

```
X = [ lagduration waiting ];
K = 2;
C = kmeans(X, K);
col1 = 'r'; col2 = 'g'; col3 = 'b'; col4 = 'm';
hold on
plot(lagduration, waiting, 'k.')
for c=1:K
loc = find( C == c );
plot(lagduration(loc), waiting(loc), 'color', colc,
'marker', 'o', 'markersize', 4, 'LineStyle', 'None');
end
```

MATLAB TUTORIAL 1: CLUSTER



MATLAB TUTORIAL 1: QUESTIONS

1. Compare the information revealed by each graph. What is gained (or lost) by each representation?
2. How useful were the summaries of location for predicting the expected waiting time to the next eruption?
3. What is your final prediction of waiting time? Can you predict more than one waiting time ahead? Will your predictions apply in 2016, and why/why not? Which graphical representation would best communicate your predictions? What other information would you provide?
4. You decide to stay in the park for the rest of the day to collect some more data and validate your prediction. The data are in `faithful15`. Import `faithful15` into MATLAB. How close are your final predictions for the next waiting times in comparison with the actual values?
5. What have you learned about (a) variation and (b) making predictions?